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Radiology and Imaging Diagnosis in Undergraduate Medicine in a Curriculum using Active Methodologies: A Systematic Review from 2011 to 2021

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***Abstract*—** *Radiology is a medical specialty that renews itself and advances every day, in a process of modernization that, in addition to investments, requires a continuous effort to update. The use of radiological images is a fundamental part of learning because of its availability and undeniable clinical relevance. Thus this study will make it possible to review how the teaching and learning of radiology and diagnostic imaging in medical education is developed in an integrated and interdisciplinary undergraduate curriculum in medicine. Objective: To identify the importance of radiology and diagnostic imaging in undergraduate medical education in a curriculum using active methodologies. Methodology: The present study is a systematic literature review, therefore it does not require ethics committee approval, it was carried out from a screening of articles in the period from January 2011 to March 2021 from two electronic databases: PubMed and Science Direct. The descriptors used in the search were "radiology" AND "medical education". Academic articles were searched for authors who correlated Active Methodologies, Medical Education, Transversal Teaching in Medical Graduation, Radiology and Diagnosis. Results and Discussion: Studies that had Active Methodologies, Medical Education or Radiology and diagnosis were included in this review, as well as literature review studies that accounted for 05 articles and editorials. To better understand the role of radiology in medical practice, it is necessary to review its history in medicine. Since the advent of imaging exams, radiology and diagnostic imaging have presented important advances in several areas. Its implementation in the curriculum was addressed by the author AL QAHTANI et al, 2014, in which he pointed out the importance of a cross-curriculum for the insertion of the axis of this skill and not only a discipline in a single period of the course, because the*

content is related to other areas of Medicine, such as Medical Pathology, Human Anatomy and Emergency and Urgent Care.With all this mentioned, it should be understood that the teaching environment should be seen as a place of individual and collective transformation, being receptive to new methodologies and new approaches to teaching and insertion of new skills to the students.

***Keywords*— medical education, radiology and active methodologies.**

I. INTRODUCTION

Radiology is a medical specialty that renews itself and advances every day, in a process of modernization that, in addition to investments, requires a continuous effort to update. Intrinsically linked to technological development, diagnostic imaging methods allow the physician to obtain information even imagined less than ten years ago, with a speed and efficiency that enhance medicine as a whole (SCATIGNO NETO,2019). The use of radiological images is a fundamental part of learning because of its availability and undeniable clinical relevance. Some studies indicate that the "early" insertion of this skill enriches the understanding of pathophysiological processes as well as anatomy. This is due to rapid technological advances, the availability and use of alternative resources for teaching anatomy and correlation with the clinic (KALAMI TR et al. , 2016). It plays an important role in modern medicine as imaging technologies have revolutionized the clinical practice of medicine in Brazil and worldwide, (CORR P. 2012), but many of the students are not properly introduced/prepared for the discipline during the first years of college or are introduced to the discipline in a non-adversarial manner.(BRANSTETTER BF et al., 2017).Radiology and diagnostic imaging represents relevant knowledge in medical education, helping in clinical diagnosis. Since this is a new study, the research is faced with the lack of current literature that demonstrates its importance.However, many students are not properly introduced/prepared for this competency during the first years of college (BRANSTETTER BF et al., 2017). Concomitantly, in most medical schools in Brazil, the set of operational and interpretative skills in radiology and diagnostic imaging is not mandatory, despite the recognition of its importance.(SILVA et al. , 2019, p.97). Medical undergraduate courses should provide theoretical and practical knowledge of radiological examinations directed to different clinical settings (AL QAHTANI et al, 2014). Thus, this study will make it possible to review how the teaching and learning of radiology and diagnostic imaging are developed in medical education, in an integrated and interdisciplinary undergraduate medical curriculum.

II. OBJECTIVE

2.1 Objective General: Identify the importance of radiology and diagnostic imaging in undergraduate medical education in a curriculum using active methodologies. 2.2 Specific Objective: To

understand the role of radiology in the current practice of medicine and reflect on the teaching of radiology in undergraduate medical courses, based on the available literature; Identify the teaching of radiology and applied diagnostics across the board in medical school.

III. METHODOLOGY

3.1 TYPE OF STUDY.

The present study is a systematic literature review, therefore it does not require ethics committee approval, it was conducted from a screening of articles in the period January 2011 to March 2021 from two electronic databases: PubMed and Science Direct. The descriptors used in the search were "radiology" AND "medical education". Academic articles were searched for authors who correlated Active Methodologies, Medical Education, Cross-cutting Teaching in undergraduate medical education, Radiology, and diagnosis.

3.2 INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria were: 1) studies with medical students or directed to medical students, 2) studies with medical residents, and 3) studies that evaluate the use of technological development in teaching human anatomy. Excluded were: 1) studies with animals, 2) studies with students from other health courses, and 3) studies involving the surgical field or surgical technique.

3.3 DATA ANALYSIS

The data were analyzed by means of analytical reading, ordering the information collected as specified in the result item, seeking to obtain the answer to the research objective.

IV. RESULTADOS

It is presented in the flowchart in Figure 1 to generally simplify the selection of articles performed by the researchers. Thus, studies that had Active Methodologies,

Medical Education or Radiology and diagnosis were included in this review, as well as literature review studies that accounted for 05 articles and editorials.

Chart 1 - collected and used academic articles

AUTHORS	TITLE	SUMMARY
Fahd Al Qahta ni and Adel Abdelaziz.	"Integrating radiology vertically into an undergraduate medical school curriculum: a three-phase integration approach". radiologyvertically into an undergraduate medical school curriculum: a three-phase integration approach".	At Al-Baha University School of Medicine, Al-Baha, Saudi Arabia, efforts have been made to integrate radiology vertically and in a structured way into the undergraduate curriculum from the first to the sixth year.
Alexandre Ferreira da Silva, Robson José de Souza Domingues, Kátia SimoneKietzerJofre and Jacob da Silva Freitas	"Medical Student Perceptions of the Insertion of Radiology into Undergraduate Education Using Active Methodologies."	Radiology in the medical course has reached a new dimension not only as acomplementary diagnostic tool, but also for its use as a teaching tool, integratedwith the study of anatomy and pathology, among other subjects.
Pablo Antonio Maia from Farias, Ana Luiza de Aguiar Rocha Martin, Cinthia Sampaio Cristo.	"Active Learning in Health Education: HistoricalCourse and Applications"	This literature review describes a brief historical background of education, arriving at student-centered education, as well as some of the most commonly used active learning methods today.
Jennifer ELim-Dunham,David C Ensminger, JohnA McNulty.	"An online radiology curriculum vertically integrated developed as cognitive learning: impact on student performance and learning"	We describe the development of the online vertical radiology curriculum and evaluate its impact on student performance and the learning process using a mixed-methods approach
Barton FBranstetter, Laura E Faix Allen L Humphrey	"Medical student preclinical training in radiology: the effect of early exposure."	The purpose of this study was to determinewhether an integrated radiology curriculum in the first year of medical school changesmedical students' attitudes toward radiology or affects their knowledge of

From the analysis, the articles were separated into 3 themes as research categories, and the following descriptors were considered: Medical education and radiology and diagnostic imaging; active methodologies and the curricular guidelines for medical education; transversality of the teaching of radiology and diagnostic imaging in medical education.

V. DISCUSSION

5.1 UNDERSTANDINGS OF THE IMPORTANCE OF THE ROLE OF RADIOLOGY AND DIAGNOSTIC IMAGING IN MEDICAL EDUCATION.

In order to better understand the role of radiology in the medical practice, it is necessary to review its history in medicine. Since the advent of imaging exams, radiology and diagnostic imaging have represented important advances in several areas. Thus, it is essential that there are professionals trained to know the techniques and proper use of these complementary exams (CHEN et al., 2006),

since the improper use of these tests implies damage to both the patient and the health system (SILVA et al., 2019).Consequently, preparing medical students to become responsible users of medical imaging, including, to this end, the teaching of radiology and diagnostic imaging in the undergraduate medical curriculum, is an increasing target of attention (LIM-DUNHAM, 2016). Some authors, such as Lewis and Shaffer, make several accounts of the importance of inserting the Axis of radiology and diagnostic imaging in the academic curriculum of the medical course, such as: teaching skills needed to interpret radiographs on an emergency basis; developing appropriate and feasible algorithms for requesting imaging methods for common clinical conditions (Lewis and Shaffer, year). In addition to understanding the concept of positive and negative predictive values of imaging exams and how to incorporate them into patient management; understanding the risks, contraindications, and limitations of imaging methods; following the exams so they can explain them to their future patients; improving their view of the disease, physiology, and anatomy; understanding the benefits of clinicaloradiologist collaboration, from the correct completion of applications and familiarization with image-guided procedures (Lewis and Shaffer, 2017).

With all this mentioned, the importance of teaching radiology and diagnostic imaging, using active devices and methodologies is unquestionable, and these must be well applied, with theories and their applicability in practice, as advocated by Piaget's constructive ideas, giving a new embodiment, a meaningful learning.

5.2 THE USE OF ACTIVE METHODOLOGIES IN LIGHT OF THE NEW CURRICULAR GUIDELINES FOR THE MEDICAL COURSE

The National Curriculum Guidelines (DCNs) of the undergraduate course in Medicine (BRASIL, 2014) defines the organization, development and evaluation of the course, within the scope of the country's higher education system and guides to the promotion of integration and interdisciplinarity in coherence with the curriculum development axis, and the use of methodologies that favor the active participation of the student in the construction of knowledge.Among the elements that make up active methodologies, two actors must be considered conceptually: the teacher, who no longer has the role of lecturer or teacher, leaving him/her with the task of facilitating the process of knowledge acquisition; and the student, who begins to receive names that refer to the dynamic context, such as student or learner.A better teaching strategy for radiology and diagnostic imaging is not so well addressed in studies, but, proactive solutions of updating should be thought for graduation. Methodological strategy that requires the active participation of the student in the construction of knowledge, its use in the teaching of radiology and diagnostic imaging in the medical course can be encouraged (Dawson et al.,2017).

Dawson et al. in a recent study demonstrated that the technique of realistic simulation, a proactive action performed mostly in medical residencies and continuing education, was effective for the acquisition of required skills. This type of activity promotes the development and improvement of theoretical and practical skills, as well as crisis management and free decision making, in a significant way, from the simulation-based teaching methodology.

5.3 ANALYSIS OF THE TRANSVERSAL TEACHING OF RADIOLOGY AND DIAGNOSTIC IMAGING IN MEDICAL EDUCATION.

In this sense, some doubts emerged related to the model, the content and the ideal period to introduce the learning of radiology and diagnostic imaging, showing the need for the elaboration of an effective means for teaching this content (SILVA et al., 2019).AL QAHTANI et al (2014), highlights that at Al-Baha University Faculty of Medicine (ABUFM) in Al-Baha - Saudi Arabia - it was scored that the best time should be during the early stages of the medical school curriculum .Alternatives to answer this question were to address radiology within other clinical disciplines through a "when indicated" approach, allocate a distinct, specialized module, or integrate a related topic longitudinally into the curriculum during their 6 academic years (AL QAHTANI et al, 2014).Since a large part of medical education routinely uses imaging studies, consequently, at some point during the undergraduate or professional life, it will be necessary to interpret imaging exams, regardless of the area, according to some of the studies discussed.In the new integrated and interdisciplinary curricula with the use of active methodologies in undergraduate medicine, the teaching of radiology and diagnostic imaging became part of the axis Attention and Health Education (AES), in the morphofunctional laboratory (LMF) (UNIFAMAZ, 2017), developed in some periods, with active methodologies and favoring the teaching method in vertically integrated internships. The assimilation of content by this means allows a lasting learning, relevant in practical and real clinical work of students (LIM-DUNHAM, 2016).The evaluation of the development of competencies in radiology and diagnostic imaging by the medical student in an integrated and interdisciplinary curriculum, using active methodology, is of significant importance for the formation of the medical professional.Since according to recent studies, the breakdown of disciplines and their reorganization in integrative axes, promotes the union of knowledge, facilitating from the physiopathological

understanding, clinical context, and mainly associating to these the complementary radiological imaging exams for a broad understanding, since, previously, medical schools used a compartmentalized disciplinary structure.

VI. CONCLUSION

It is not new that the teaching of radiology and diagnostic imaging is going through a transformation moment, once its importance is already recognized, as mentioned by some authors, and the need to develop this medical knowledge is unquestionable: interpretation of radiographs in an emergency, when to request complementary imaging exams, are some examples of its great value in teaching and learning for medical graduation, forming general practitioners skilled in this knowledge.Its implementation in the curriculum was addressed by the author AL QAHTANI et al, 2014, in which he pointed out the importance of a transversal curriculum for the insertion of the axis of this skill and not only a discipline in a single period of the course, because the content is related to other areas of Medicine, such as Medical Pathology, Human Anatomy and Emergency and Urgent Care, among others.It was also observed the positive predictive value of the teaching of this axis, incorporating the active and integrative teaching methodologies, as already mentioned, some sites already use even realistic simulation resources for the use of this radiological apparatus for the proper learning of the student, as well as its early insertion.With all this mentioned, it should be understood that the teaching environment should be seen as a place of individual and collective transformation, being receptive to new methodologies and new approaches to teaching and to the insertion of new skills for the students.

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